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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/762,163 | 01/20/2004 | Mohammad Yunus | TI-33423A | 3755 |
| 23494 | 7590 | 08/26/2004 | EXAMINER | |
| TEXAS INSTRUMENTS INCORPORATED | | | OWENS, BETH E | |
| P O BOX 655474, M/S 3999 | | | ART UNIT | |
| DALLAS, TX 75265 | | | PAPER NUMBER | |
| | | | 2824 | |

DATE MAILED: 08/26/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/762,163

Applicant(s)

YUNUS ET AL.

Examiner

Beth E. Owens

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 15-26 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 15-26 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 20 January 2004 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date <u>01202004</u> . | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Drawings

1. The drawings are objected to because the drawings are too dark to clearly see what is illustrated. Corrected FORMAL drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as “amended.” If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. The replacement sheet(s) should be labeled “Replacement Sheet” in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Specification

2. The disclosure is objected to because of the following informalities:

Page 2, line 9: please replace “involving” with --involve--.

Page 7, line 9: please replace “loose” with --lose--.

Page 10, line 7: please insert --now U.S. Pre-Grant Publication
#2003/0141593-- after “10/057,138,”.

Page 10, line 9: please insert --now U.S. Pre-Grant Publication
#2003/0116845-- after “10/086,117,”.

Page 13, line 15: please replace “layer 212” with --layer 211--.

Appropriate correction is required.

3. The abstract is objected to as failing to describe the invention of the instant application, which is directed to a method of manufacturing a metallurgical interconnection, not the device. Correction is required. See MPEP § 608.01(b).

4. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

The following title is suggested: “Method of Fabricating a Contact Structure for Reliable Metallic Interconnection”.

Claim Objections

5. The following Claims are objected to because of the following informalities:

Claim 15, line 5: please start “wherein” on the following line.

Claims 16-26, line 1: please insert a comma after “Claim X”.

Claim 20, line 1: please replace “first-metal-shape” with --first metal shape--.

Claim 20, line 2: please delete “the”.

Correction is required.

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

7. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wu et al.

In regards to claim 15:

A method for forming a metallurgical interconnection for electronic devices, comprising:

providing a first interconnection metal having contact area and surface affinity to forming metallurgical contacts;

and providing a second interconnection metal capable of reflowing;

wherein said first metal is shaped to maximize said contact area, consequently to increase the interconnection strength, and to stop nascent cracks propagating in said interconnection.

Column 1, lines 45-49: Accordingly, one object of the present invention is to provide a bonding pad structure and a method of forming the bonding pad structure on a substrate for increasing contact area and hence adherence with a conductive wire.

Column 1, lines 58-60: The invention also provides a method of forming the bonding pad structure. First, a metallic bonding pad is formed over a substrate.

Column 2, lines 3-7: Since the bonding pad of this invention has a rugged surface profile, contact area of the bonding pad is increased. Hence, a conductive wire bonded to the bonding pad can have a higher adhesive strength resulting in a higher production yield.

Column 2, lines 56-57: The metallic bonding pad 210 can be, for example, a layer of aluminum/copper alloy.

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Column 3, lines 48-53: FIG. 3 is a cross-sectional view showing the metallic bonding pad of this invention with an attached conductive wire. When compared with a similarly attached conductive wire to a conventionally fabricated bonding pad in FIG. 1B, contact area between the conductive wire 250 and the metallic bonding pad 210 in FIG. 3 is greater.

Wu et al. are silent in regards to the second interconnection metal being capable of reflowing. Although the invention of Wu et al. is applied to a wire bonding technique, in which the wire would conventionally be Au or Al, the main concept of the invention of the contoured surface of the bond pad for increased surface area could as easily been applied by one ordinarily skilled in the art at the time it was made to solder bonding, in which the second metal is capable of reflowing, for the purpose of improving the quality of the bond joints.

Wu et al. are also silent in regards to the first metal being shaped to stop nascent cracks in propagating in the interconnection. Wu et al. do not disclose that the first metal is shaped specifically to stop nascent cracks; however, as the structure of Wu et al. is consistent with that of Applicant's, it is inferred that Wu et. al.'s bond pad shape would also stop nascent cracks.

In regards to Claim 16:

The method according to Claim 15, wherein said first metal shape comprises castellations and corrugations.

Column 3, lines 7-9: Ultimately, a plurality of grooves or cavities 215 is formed in the upper surface of the bonding pad 210.

Column 3, lines 34-36: FIGS. 2F and 2G are top views of FIG. 2E showing two different patterns on the surface of the metallic bonding pads.

Column 3, lines 41-45: The bonding pad 210 is patterned into an array of separate square-shaped islands as shown in FIG. 2F. On the other hand, the bonding pad may be patterned into a series of parallel strips as shown in FIG. 2G.

In regards to Claim 17:

The method according to Claim 16, wherein said castellation and corrugation is created by stamping or etching.

Column 3, lines 4-8: As shown in FIG. 2C, an anisotropic etching is again conducted to remove a portion of the bonding pad material exposed by the openings 215 while using the passivation layer 220 as a mask. Ultimately, a plurality of grooves or cavities 215 is formed in the upper surface of the bonding pad 210.

In regards to Claim 18:

The method according to Claim 15, further comprising forming predetermined contours of said first metal arranged in concentric, parallel, or repetitive patterns.

Column 3, lines 41-45: The bonding pad 210 is patterned into an array of separate square-shaped islands as shown in FIG. 2F. On the other hand,

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the bonding pad may be patterned into a series of parallel strips as shown in FIG. 2G.

In regards to Claim 19:

The method according to Claim 16, wherein said castellation and corrugation create grooves suitable for venting air during the reflow process by which said interconnection is created.

It is inferred that the grooves of Wu et al. would perform in the same manner as that of Applicant's grooves as the structures are similar. It is also well known to one ordinarily skilled in the art that vias and gaps or grooves in the bonding pads help vent the air during a reflow process.

In regards to Claim 20:

The method according to Claim 15, wherein said first metal shape comprises protrusions creating wall-like obstacles in the interconnection zones of highest thermo-mechanical stress to stop propagating cracks.

As Applicant's first metal shape is similar to that of Wu et al.'s, the walls of Wu et al.'s square-shaped islands would also perform like the wall-like obstacles in the interconnection zones of highest thermo-mechanical stress to stop propagating cracks.

In regards to Claims 21 and 23:

The method according to Claim 15, wherein said first interconnection metal is a copper layer having a thickness between 10 and 30 μm .

Claim 3 recites: The method of claim 1, wherein the metallic bonding pad has a total thickness of between 3000Å and 8000 Å. This corresponds to 30 µm-80µm.

Wu et al. discloses in column 2, lines 56-57 their metallic bonding pad to be, for example, an aluminum/copper alloy. Examiner takes Official Notice that one ordinarily skilled in the art at the time the invention was made would have also used copper bonding pads for the purpose of good conductivity.

The method according to Claim 15, wherein said first interconnection metal is a copper layer of a thickness between 0.8 and 5 µm.

Although the above limitation was not disclosed by Wu et al., as no factual basis for special qualities of a film of this thickness range has been disclosed by Applicant, the general range of the thickness of the bond layer does not make this invention novel.

In regards to claims 22 and 24:

The method according to Claim 20, wherein said contact area is at least two times greater than the area of flat surface geometry.

The method according to Claim 23, wherein said contact area is at least 25 % greater than the area of flat surface geometry.

Claim 14 recites: The structure of claim 13, wherein a difference in height level of the patterned bonding pad surface is between 1000Å and

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3000Å. This would be sufficient difference in elevation for an array of separate square-shaped islands as illustrated for increasing surface area by a factor of 2.

In regards to claim 25:

The method according to Claim 15, wherein said surface affinity for metallurgical contacts is provided by a flash of gold, nickel/gold, or nickel/palladium.

Examiner takes Official Notice that one ordinarily skilled in the art at the time the invention was made would have used a flash of gold to provide an excellent surface for securing a good solder wettability and bonding quality.

In regards to claim 26:

The method according to Claim 15, wherein said second interconnection metal is selected from a group consisting of tin, tin alloys including tin/indium, tin/silver, tin/bismuth, tin/lead, three-phase alloys, conductive adhesives, and z-axis conductive materials.

Examiner takes Official Notice that tin and tin alloys would have been commonly used by someone ordinarily skilled in the art at the time the invention was made for the purpose of solder bonding.

8. The following prior art, which is considered pertinent to applicant's disclosure although not relied upon, includes "Eclipse Via in Pad Structure" by Barrow; "Substrate Structure and Method for Improving Attachment Reliability of Semiconductor Chips and Modules" by Desai et al.; "Vented

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Vias for Via in Pad Technology Yield Improvements” by McCormick et al.;
and “Method and Structure for Joining Two Substrates with a Low Melt
Solder Joint” by Jimarez.


Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Beth E. Owens, Ph.D., whose telephone number is 571.272.1882 and fax number for unofficial communications is 571.273.1882.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Richard Elms, can be reached on 571.272.1869. The fax phone number for the organization where this application or proceeding is assigned is 703.872.9306 for official communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 571.272.2800.

BEO 08.23.04


RICHARD ELMS
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800